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An Implementation of the Hybrid Genetic Algorithm based Routing for MANET

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***Abstract*— MANET is a new generation communication network. In this kind of network devices are connected using the wireless links, with their random mobility. Due to their mobility the network topology is never fixed that is dynamically organized and perform cooperative communication for delivering data between target nodes. Due to their ad hoc nature routing works as backbone to support communication that is responsible for topology formation and data delivery. This paper addresses the issues of routing technology adopted over MANET. In addition of that, a new hybrid routing strategy is defined in order to achieve more reliable communication in MANET network. The implementation of the proposed routing algorithm is given using NS3 network simulation environment. The obtained results demonstrate the effectiveness over the traditional routing technique and gain advantage over throughput.**

Keywords-MANET; Routing; Network Simulation; Hybrid Routing; Performance Improvement.

I. INTRODUCTION

A wireless ad hoc network is a decentralized type of wireless network. The network is ad hoc because it does not rely on a pre-existing infrastructure, such as routers in wired networks or access points in managing wireless networks. Instead, each node participates in routing by forwarding data to other nodes, so the determination of which nodes forward data is made dynamically on the basis of network connectivity. In addition to the classic routing, ad hoc networks can use flooding for forwarding the data [1].

An ad hoc network typically refers to any set of networks where all devices have equal status on a network and are free to associate with any other ad hoc network device in link range. Ad hoc network often refers to a mode of operation of IEEE 802.11 wireless networks.

The earliest wireless ad-hoc networks were the PRNETs. An ad-hoc network is made up of multiple “nodes” connected by “links”. Links are influenced by the node's resources and behavioural properties, as well as link properties. Since links can be connected or disconnected at any time, a functioning network must be able to cope with this dynamic restructuring, preferably in a way that is timely, efficient, reliable, robust, and scalable.

An ad hoc routing protocol is a convention, or standard, that controls how nodes decide which way to route packets between computing devices in a mobile ad hoc network. In ad hoc networks, nodes do not start out familiar with the topology of their networks; instead, they have to discover it. The basic idea is that a new node may announce its presence and should listen to announcements broadcast by its neighbors. Each node learns about nodes nearby and how to reach them, and may announce that it, too, can reach those [2].

A. *Proactive (table-driven) routing:* This type of protocols maintains fresh lists of destinations and their routes by periodically distributing routing tables throughout the network. The main disadvantages of such algorithms are:

1. Respective amount of data for maintenance.
2. Slow reaction on restructuring and failures.

B. *Reactive (on-demand) routing:* This type of protocols finds a route on demand by flooding the network with Route Request packets. The main disadvantages of such algorithms are:

1. High latency time in route finding.
2. Excessive flooding can lead to network clogging

C. *Flow-oriented routing:* This type of protocols finds a route on demand by following present flows. One option is to unicast consecutively when forwarding data while promoting a new link. The main disadvantages of such algorithms are:

1. Takes long time when exploring new routes without a prior knowledge.
2. May refer to existing traffic to compensate for missing knowledge on routes.

D. *Hybrid (both pro-active and reactive):* This type of protocols combines the advantages of proactive and of reactive routing. The routing is initially established with some proactively prospected routes and then serves the Demand from additionally activated nodes through reactive flooding. The choice for one or the other method requires predetermination for typical cases. The main disadvantages of such algorithms are:

1. Advantage depends on the number of nodes activated.
2. Reacting to traffic demand depends on the gradient of traffic volume.

E. *Hierarchical routing protocols:* With this type of protocols the choice of proactive and of reactive routing depends on the hierarchic level where a node resides. The routing is initially established with some proactively prospected routes and then serves the demand from additionally activated nodes through the reactive flooding on the lower levels. The choice for one or the other method requires proper attribution for the respective levels. The main disadvantages of such algorithms are:

1. Advantage depends on the depth of nesting and addressing scheme
2. Reacting to traffic demand depends on meshing parameters

F. *Backpressure Routing:* This type of routing does not pre-compute paths. It chooses next-hops dynamically as a packet is in progress toward its destination. These decisions are based on congestion gradients of neighbor nodes. When this type of routing is used together with max-weight link scheduling, the algorithm is throughput-optimal. See further discussion here: Backpressure Routing.

G. *Host Specific Routing protocols:* This type of protocols requires thorough administration to tailor the routing to a certain network layout and a distinct flow strategy, the main disadvantages of such algorithms are:

1. Advantage depends on the quality of the administration addressing scheme.
2. Proper reaction to changes in topology demands reconsidering all parameters

H. *Power-aware routing protocols:* Energy required to transmit a signal is approximately proportional to $d\alpha$, where d is the distance and $\alpha>=2$ is the attenuation factor or the path loss exponent, which depends on the transmission medium. When $\alpha=2$ (which is the optimal case), transmitting a signal half the distance requires one fourth of the energy and if there is a node in the middle willing to spend another fourth of its energy in the second half, data would be transmitted for half of the energy than through a direct transmission- a fact that follows directly from the inverse square law of physics. The main disadvantages of such algorithms are:

1. This method induces a delay for each transmission.
2. No relevance for energy network powered transmission operated via sufficient repeater infrastructure

II. PROPOSED WORK

Multi-hop wireless networks typically use routing techniques similar to those in wired networks. These traditional routing protocols choose the best sequence of nodes between the source and destination, and forward each packet through that sequence. In contrast, cooperative diversity schemes proposed by the information theory community suggest that the traditional routing may not be the best approach. Cooperative diversity takes advantage of broadcast transmission to send information through multiple relays concurrently. The destination can then choose the best of many relayed signals, or combine information from multiple signals. These schemes require radios capable of simultaneous, synchronized repeating of the signal, or additional radio channels for each relay [3]. As we are working on a dynamically changing network problem and optimum route discovery, thus we can involve both kinds of routing in our problem domain. In the next section of our paper, we provide the similar works and efforts that previously made for route discovery and optimum data delivery algorithms.

Our basic problem of the MANET is their ad hoc nature where not any fixed points are available for dynamically moving nodes (devices). That is observed using a simple example, in the “Fig. 1” below diagram a wireless network is given and there are two nodes are available with label A and B. suppose node A want to send some data to B, then path is discovered first then data flooding is initiated.

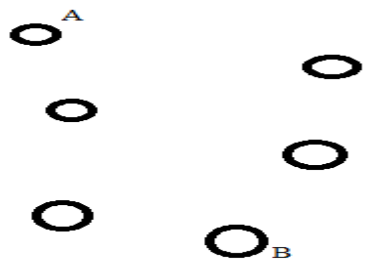

Figure 1. Node at a Time Instance

But due to mobility if node B changes their position from one place to other then problem arises for communication point of view. In addition of that to manage the efficiency and power consumption is another problem which leads to store less data on nearest nodes.

A. *GENETIC ALGORITHMS*

Genetic algorithm is one of the popular approaches for making search for large amount of data. The Bioinformatics knowledge is used to find the fittest answers in a number of repetitive or iterative calculations. So first we discuss the primary functioning of the genetic algorithm. The evolutionary algorithms use the three main principles of the natural evolution: reproduction, natural selection and diversity of the species, maintained by the differences of each generation with the previous [4].

Genetic Algorithms work with a set of individuals, representing possible solutions of the task, the selection principle is applied by using a criterion, giving an evaluation for the individual with respect to the desired solution. The best-suited individuals create the next generation.

- *Generate an initial population* – The algorithms in First generation randomly generated, by selecting the genes of the chromosomes among the allowed alphabet for the gene. Because of the easier computational procedure, it is accepted that all populations have the same number (N) of individuals, Calculation of the values of the function that we want to minimize or maximize.
- *Check for termination of the algorithm* – As in the Most optimization algorithms it is possible to stop the genetic optimization by: Value of the function, Maximum number of iterations, Stall generation.
- *Selection* – Between all individuals in the current Populations are choosing those, who will continue and by means of crossover and mutation will produce offspring population. At this stage elitism could be used – the best n

individuals are directly transferred to the next generation. The elitism guarantees, that the value of the optimization function cannot get worse (once the extreme is reached it would be kept).

- *Crossover* – The individuals chosen by selection

Recombine with each other and new individuals will be created. The aim is to get offspring individuals, which inherit the best possible combination of the characteristics (genes) of their parents.

- *Mutation* – By means of random change of some of

The genes, it is guaranteed that even if none of the individuals contain the necessary gene value for the extreme, it is still possible to reach the extreme.

- *New generation* – The elite individuals chosen from

The selections are combined with those who passed the crossover and mutation, and form the next generation.

B. K-NEAREST-NEIGHBOUR (KNN) ALGORITHM

The K-nearest-neighbor (KNN) algorithm measures the distance between a query scenario and a set of scenarios in the data set. We can compute the distance between two scenarios using some distance function d(x, y), where x, y are scenarios composed of features, such that

X={x1, x2, x3...}
Y={y1, y2, y3...}

Two distance functions are discussed here:
Absolute distance measuring:

$$\mathbf{d_A(x,y)} = \sum_{i=1}^{N} |\mathbf{x_i} - \mathbf{y_i}|$$

Euclidean distance measuring:

$$\mathbf{d_A(x,y)} = \Sigma_{i=1}^{N} \sqrt{\mathbf{x_i^2} - \mathbf{y_i^2}}$$

Because the distance between the two scenarios is dependant of the breaks, it is suggested that resulting distances be scaled such that the arithmetic mean across the dataset is 0 and the standard deviation is 1. This can be accomplished by replacing the scalars with according to the following function:

$$\mathbf{x'} = \frac{x - \bar{x}}{\sigma(x)}$$

Where the un-scaled value is the arithmetic mean of feature across the dataset, is its standard deviation, and is the resulting scaled value.
The arithmetic mean is defined as:

$$\bar{x} = \frac{1}{N} \sum_{i=1}^{N} x_i$$

We can then compute the standard deviation as follows:

$$\sigma(x) = \sqrt{\frac{1}{N} \sum_{i=1}^{N} (x_i - \bar{x})^2}$$

KNN can be run in these steps:

1. To store the output values of the M nearest neighbors to Query scenario Q in the vector R = {r_1…... r_m} by repeating the following loop M times:
   a. Go to the next scenario S_i in the data set, where I is the current iteration within the domain {1……P}
   b. If Q is not set or q < d (q, S_i): q←d (q, S_i), t← O_i
   c. Loop until we reach the end of the data set.
   d. Store q into vector c and t into vector r.
2. Calculate the arithmetic mean output across r as follows:

$$\bar{r} = \frac{1}{M} \sum_{i=i}^{M} r_i$$

3. Return r as the output value for the query scenario q

III. ALGORITHM DESIGN

The genetic algorithm is initiated with a set of randomly generated population with allowed alphabets in the stream used form application here the number of nodes and their corresponding node alphabets are used in our proposed protocol.

Uses of the genetic algorithm in search problems are a traditional way of computing. In the genetic algorithm, Algorithm process all the possible conditions and return the most optimum or fittest values in each step of execution or generation. To limit calculation and termination of the genetic algorithms, three different processes are involved or suggested which is described below in brief.

- *The value of the function* – The value of the

Function of the best individual is within a defined range around a set value.

- *Maximal number of iterations* – This is the most

widely used stopping criteria. It guarantees that the algorithms will give some results within some time, whenever it has reached to peak or not;

- *Stall generation* – If the number of iterations

(Generations) set initially there is no improvement of the value of the fitness function of the best individual the algorithm stops.

In addition of that the number of generating population in any genetic algorithm is also required to reduce, by reducing these populations the execution of the algorithm is becoming faster than traditional execution time, so to improve the performance of genetic algorithm we apply changes in two basic steps first step involves in population distance evaluation using the below given distance function.

$$D(x,y) = \sum_{k=0}^{n} |x_k - y_k|$$

Here the most nearest values are evaluated for the next generation. In the next step termination of the algorithm is done by reducing the number of generations using the fitness values. As we know that initial system generates and evaluates all the possible node combination for finding the next generation population values, but most of them are not possible in practical system. Thus the unutilized or impossible node combinations are reduced in this part of the algorithm. Thus the proposed system can be summarized using the Table 1 below given steps:

TABLE I. PROPOSED ALGORITHM

Input: No. of Nodes
Outcome: Routes
Process:
1. Generate an initial populations
2. For each generated population
a. Select two random sequences
b. Compare to find distance using sequence seq_a and seq_b
c. If distance> .5 than
d. Remove a sequence
e. End if
3. Check the termination condition
4. Perform Selection, Crossover, and Mutation
5. Get new generation
6. Remove impossible sets of nodes
7. Go to step 3

The proposed algorithm is a hybrid algorithm which is designed using genetic algorithm and KNN algorithm. Where the processing steps are inherited from genetic algorithm and

The distance measurement and node elimination process is derived using the KNN algorithm.

A. SIMULATION SETUP

To simulate the research work we working around various software simulation network tools, and we found the NS3 network simulator which is a discrete event network simulator where all the participating devices can be visualized by the nodes and the corresponding network utilities can be insoluble. Moreover, it simulation required additional script writing for performing the experiments using python or using C++ scripts. The user has freedom to select their own language for scripting. Once the network script is compiled and executed some additional files are generated to get the network information for performance evaluation and animation of network and created scenario. For visualization NETANIM can be used and for performance graph and results GNUPLOT is a good utility for use.

To simulate our proposed work we first setup, network environment in table 2. Then we simulate and compare our proposed techniques in the three scenarios.

TABLE II. PROPOSED SIMULATION SETUP

Parameters	Description
Number of node	10,20,30, 40,50,60
Mobility model	RandomWalk2dMobilityModel
Simulation time	50 sec
Simulation size	500 X 500
Routing protocol	AODV and Genetic
Loss Model	FixedRssLossModel
Data Rate	500kb/s

Network simulation having two most important part first parameters required for network simulation and second the simulation of network scenario for performing the experiments and results evaluation in “Fig. 2”.

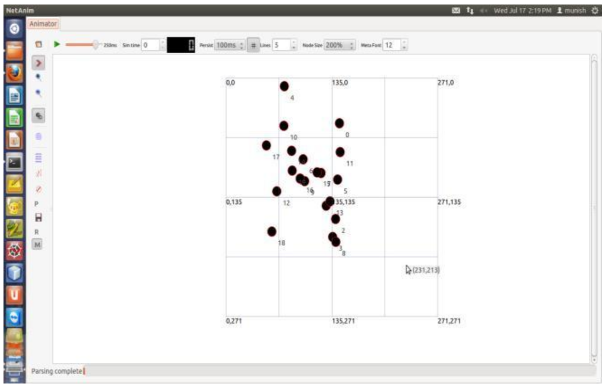

Figure 2. NETANIM Snapshot

- Implementation of MANET using AODV protocol: in this network scenario we implement a network using AODV routing protocol over a variable number of nodes in the network.Units
- Implement enhanced genetic algorithm and measure their performance: here we implement and modify the network protocol and implement genetic algorithm in the traditional AODV protocol.

B. RESULT ANALYSIS

This document provides the performance analysis of the proposed routing protocol with respect to the AODV routing protocol. For performance analysis, we use more than one performance parameters.

The drop ratio, of both protocols, packet drop ratio is estimated by the below given formula:

$$\text{packet drop ratio} = \frac{\text{total drop packets}}{\text{total sent packets}}$$

Estimated Packet Drop Ratio (packet drop ratio) is provided using the given “Fig 3”.

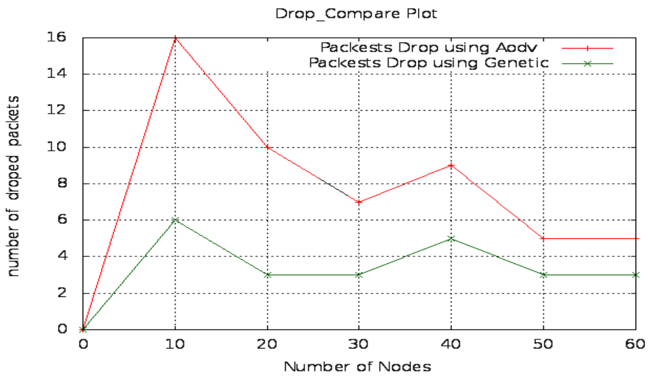

Figure 3. Packet Drop Ratios

In the above given graph result shows the number of increasing nodes in X axis and in Y axis provides the packet drop during experiments, where red line shows the AODV routing performance and green line shows the genetic algorithms performance. After analysis, we can find less packet drop during dynamically changed topology.

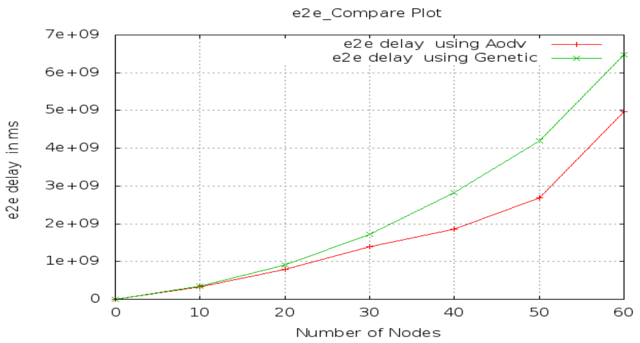

Figure 4. End to End Delays

End-to-end delay in "Fig 4" refers to the time taken for a packet to be transmitted across a network from source to destination

$$D_{end2end} = N[D_{trans} + D_{prop} + D_{proc}]$$

$D_{end2end}$ = end-to-end delay

D_{trans} = transmission delay

D_{prop} = propagation delay

D_{proc} = processing delay

Where,

N= No. of links (No. of Routers +1)

The above given graph results shows in "Fig. 4" the end to end delay of network simulation where the red lines shows the AODV routing delay and the green line shows the performance of genetic algorithm based routing protocol.

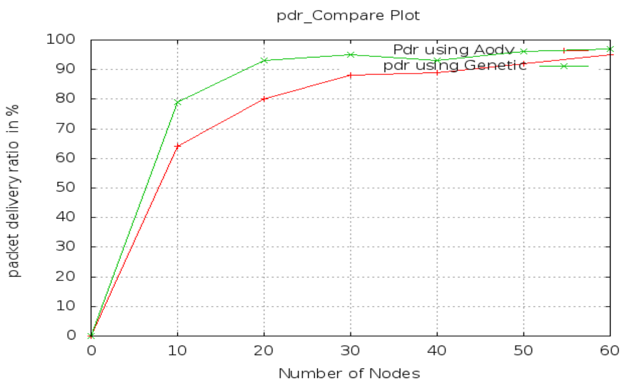

Figure 5. Packet Delivery Ratios

Packet delivery ratio provides information about the performance of any routing protocols showing in "Fig. 5". Where Packet Delivery Ratio is estimated using the formula given:

$$\text{packet delivery ratio} = \frac{\text{total delivered packets}}{\text{total sent packets}}$$

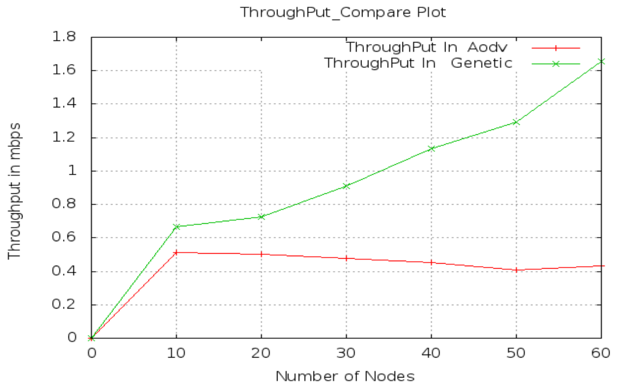

Figure 6. Throughput

Throughput provides the efficiency of the system and given using the above given "Fig 6". After evaluation of the performance parameters we can see that the overall performance of the proposed genetic algorithm is much more efficient than the traditional routing protocol AODV.

In the above given results of throughput and packet delivery ratio, in both cases we found the adoptable results.

IV. CONCLUSION

In the proposed study, work described in the above section provides the design and implementation of a genetic algorithm based routing protocol. To identify the need of the protocol we study various routing protocols by which we get the problem domain and the solution domain. To design the protocol we study the codes of AODV routing protocol and find the place where required to make changes and implementation of this routing protocol performed using C++ scripts which is listed at the end of the document. After implementation of the proposed routing protocol we evaluate the results of the designed routing protocol under Various performance parameters and we found the results. The overall performance of desired system is adaptable and high performance, as expected.

The future of ad- hoc networks is really appealing, giving the vision of—anytime, anywhere and cheap communications. Before those imagined scenarios come true, huge amount of work is to be done in both research and implementation. The study of the proposed work is completed yet and the performance evaluation is completed after that we found the proposed genetic algorithm based routing protocol provide high performance Quality of Service parameters and adopted for use. In near future we stick with the same concept and work for security issue with the same routing protocols.

ACKNOWLEDGMENT

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